

Effects of Various Canopy Configurations on Vessel ETHAN ALLEN's Ability to Satisfy USCG Stability Standard

November 1, 2005

Summary

The data presented in this analysis demonstrate that the 1989 modification to the canopy of the ETHAN ALLEN resulted in a substantially safer vessel according to the USCG stability standard.

Background

Scarano Boat Building, Inc. (SBI), on October 5, 2005, conducted a USCG Simplified Stability Test and Inclining Analysis on the De Champlain, sister ship of the Ethan Allen. The NTSB requested the test as part of its investigation into the October 2, 2005 capsizing of the Ethan Allen in Lake George, NY. In addition to other factors, the NTSB has noted that the canopy was modified in 1989 after the boat's arrival in NY and has shown interest in the effect of this modification on the stability of the vessel.

SBI has examined the photographic record of the original metal and canvas canopy and developed weights and elevations for the pipe frame using all of the possible framing materials (steel, awning tube and aluminum). See Figure 6. This data was used to determine the vessel's weight and center of gravity (CG) for each configuration. The effect of each of the possible prior canopy configurations along with the current configuration was examined for both its effect on righting moment and the USCG Simplified Stability Test Standard (available righting moment (RM) at 14° heel angle.)

The USCG Simplified Stability Requirement (as adopted by NYS) requires that at a 14° heel angle, the vessel with the original (pre 1989) canopy resist greater of 15,166 ft-lbs from the effects of wind heel or 11,659 ft-lbs from passenger heeling moment, whichever is greater. The requirement for the post 1989 canopy is to resist the greater of 12,565 ft-lbs (wind heel) or 11,659 ft-lbs for passenger heel. The reduced requirement is the result of the post '89 canopy being 1.25ft. lower. (See attached Canopy Relative Heights Sketch, Appendix 7).

Results

In order to put the effect of the canopy modification into perspective, the results are presented for both a hypothetical vessel that had the stability required by the standard and the actual vessel that demonstrated about half of the required stability when tested. Figure 1 presents the required and available RMs for the vessels before and after the canopy modification. RM data is presented for all three of the possible original pipe canopy frame materials since the material of construction has not been identified at this point.

Figure 1

Effect of Canopy Modification on Vessel Having Actual and Required Stability

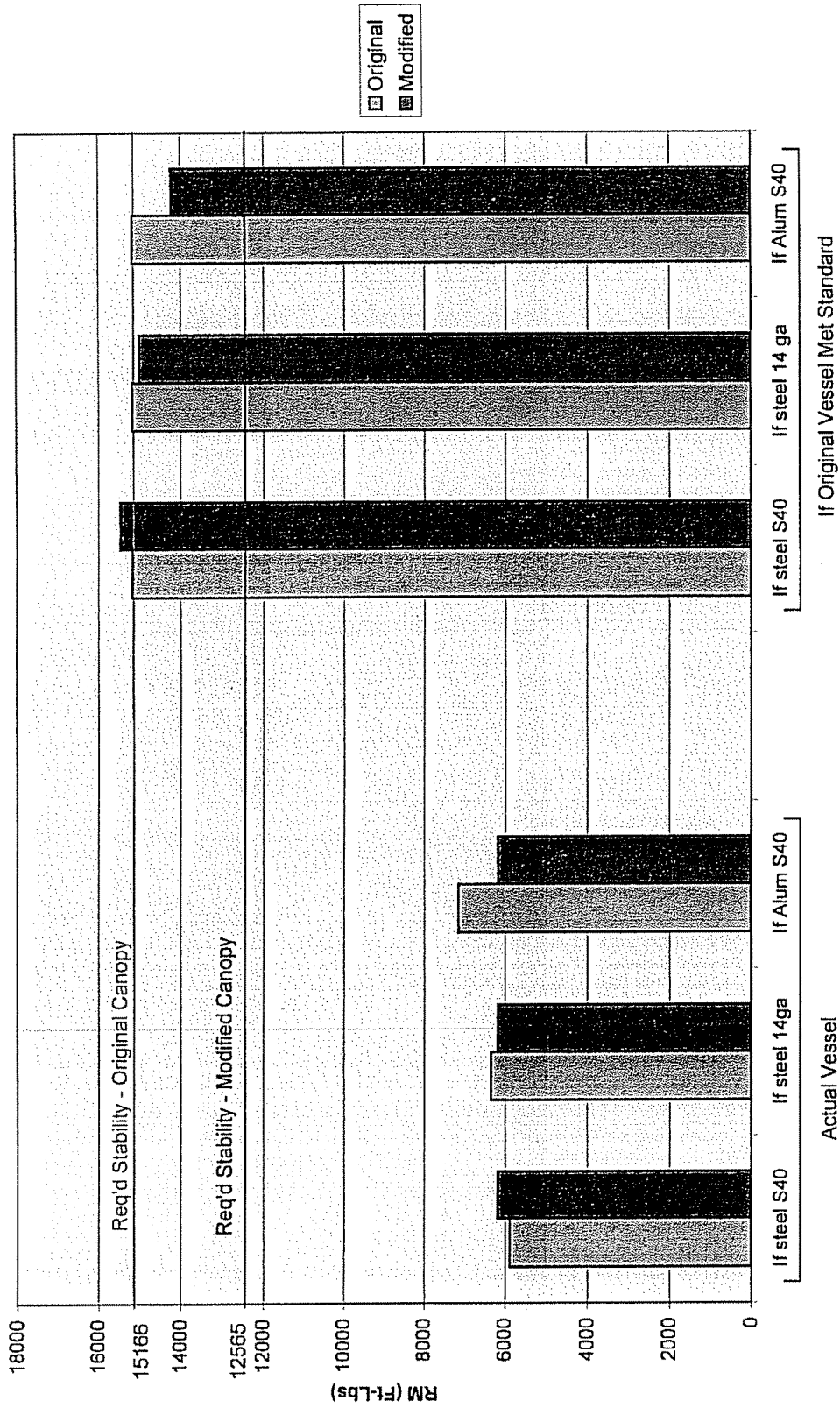
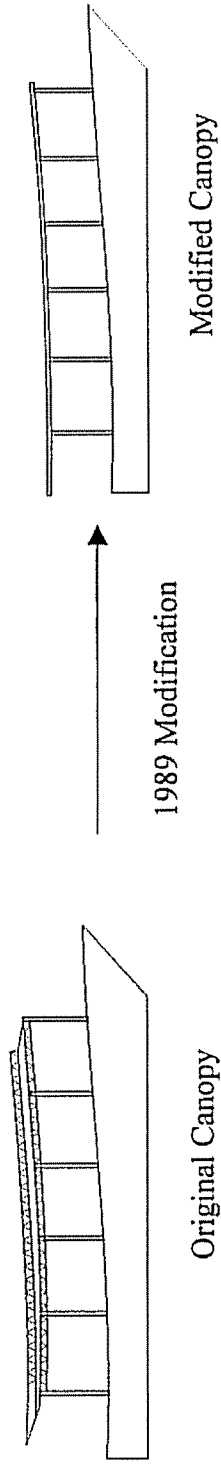


Table 1



Hypothetical Vessel With Stability Req'd by USCG Standard	Original Canopy Material	Required Righting Moment	Available Righting Moment	Reg. Wind Heel Load Req'mt	Req. Pass. Load	Vessel RM above Wind Heel	Vessel RM above Passenger Heel Stability Test Requirement	1989 Canopy Modification				Available Righting Moment Ft-lbs	Reg. Wind Heel Load Req'mt	Req. Pass. Load Req'mt.	Ft-lbs Vessel RM above Wind Heel Stability Test Requirement	Ft-lbs Vessel RM above Passenger Heel Stability Test Requirement	
	Steel S40	15,166	15,166	15,166	11,659	0	+3,507	↑	15,464	12,565	11,659	2,808	3,805				
	Steel 14ga.	15,166	15,166	15,166	11,659	0	+3,507		15,003	12,565	11,659	2,347	3,344				
	Alum. S40	15,166	15,166	15,166	11,659	0	+3,507		14,209	12,565	11,659	1,553	2,550				
Actual Vessel																	
	Steel S40	15,166	5,881	12,656	11,659	-6,775	-5,778										
	Steel 14ga.	15,166	6,342	12,656	11,659	-6,314	-5,317		6,179	12,565	11,659	-6,477	-5,480				
	Alum. S40	15,166	7,136	12,656	11,659	-5,520	-4,523										

Table 1 is a spreadsheet of more complete RM data for the hypothetical and actual vessel. This data shows the RM effect of the canopy modification had the original canopy been fabricated of Sched. 40 steel pipe framing, 14ga. steel pipe framing or aluminum framing.

Explanation of Data in Table 1

Six rows of data are shown. These give the Righting Moment data for the six possible conditions examined which are the three original canopy materials on the hypothetical vessel having the required stability and the actual vessel.

Required Righting Moment:

The Required Righting Moment is taken from the USCG Simplified Stability Test. It is the greater of the required Wind Heel and the required Passenger Heel. The required RM for the original canopy was 15,166 (greater of 15,166 Wind Heel and 11,659 Passenger Heel). The required RM for the modified canopy is 12,565 (greater of 12,565 Wind Heel and 11,659 ft-lbs Passenger Heel).

Available Righting Moment:

- Hypothetical vessel pre '89: Defined to be 15,166 ft-lbs
- Hypothetical vessel post: '89: 15,166 plus or minus the calculated effect of the modified canopy. See next paragraph.
- Actual vessel pre '89: Post '89 (current config. Measured RM) plus or minus calculated effect of modified canopy.
- Actual vessel post '89: Actual measured value (from Simplified Stability and Inclining Analysis).

Calculated Effect of Modified Canopy:

This is the difference between RM of the Actual vessel in the final configuration minus the RM of the vessel in the original configuration. Referring to Table 1, for an original S40 steel frame canopy, for example, the effect of the modification is $6179 - 5881 = +298$ ft-lbs. In other words, the available RM was increased by 298 ft-lbs. If the original canopy had been 14ga steel frame, the modification decreased the RM by 163, if aluminum the modification would have reduced the RM by 957 ft-lbs

Required Wind Heel:

This is calculated according to the method in the Simplified Stability Test.

Required Passenger Heel:

This is calculated according to the method in the Simplified Stability Test.

The data shows that a vessel that actually possessed the stability to be certificated to the USCG Standard would not have been compromised by the 1989 modification of the canopy. In fact, the data shows that the modification would have resulted in a safer vessel according to the rule.

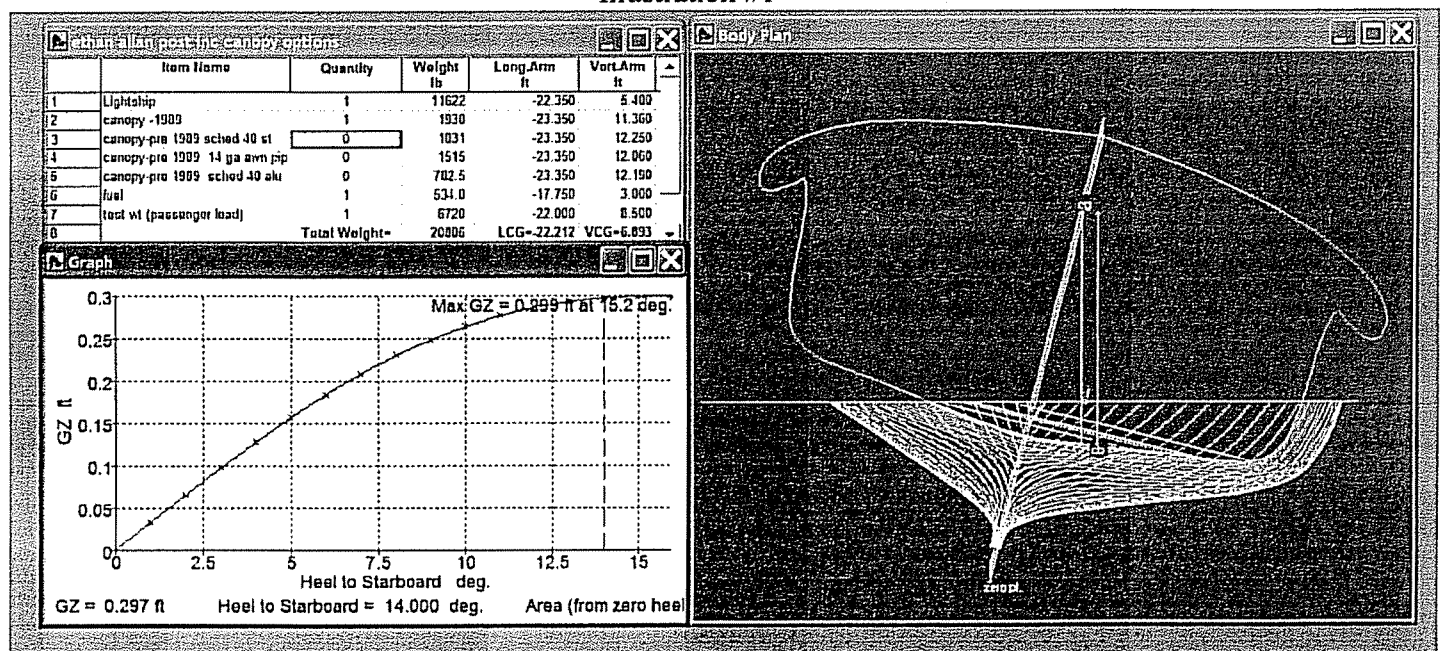
Heel Analysis:

Loading condition for each analysis was adjusted for various possible canopy configurations. Tankage and passenger weights were included to simulate Simplified Stability Test loading condition. Each Illustration demonstrates vessel's available RM at USCG Simplified Stability Test 14° maximum heel angle.

Loading condition showing existing canopy separated from Lightship characteristics to allow for various canopy configurations to be analyzed is shown below:

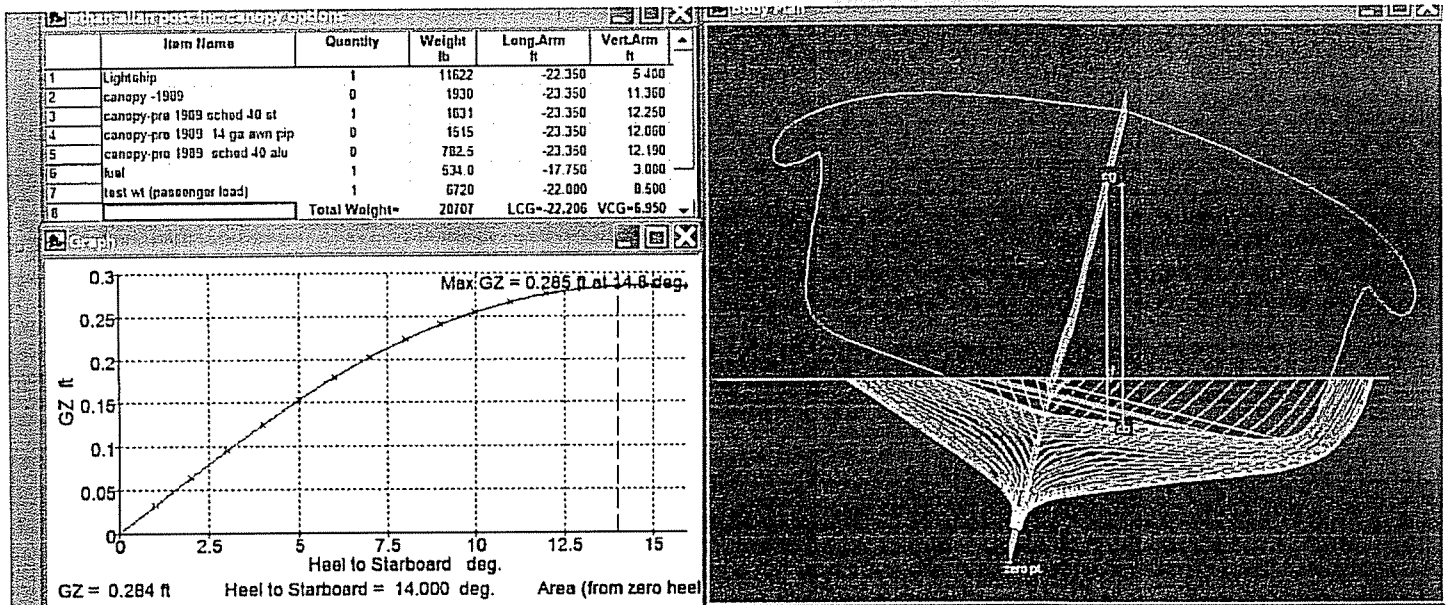
ethan allan post inc canopy options						
	Item Name	Quantity	Weight lb	Long.Arm ft	Vert.Arm ft	
1	Lightship	1	11622	-23.269	5.400	
2	canopy -1989	1	1930	-23.350	11.360	
3	canopy-pre 1989 sched 40 st	0	1831	-23.350	12.250	
4	canopy-pre 1989 14 ga awn pip	0	1515	-23.350	12.060	
5	canopy-pre 1989 sched 40 alu	0	782.5	-23.350	12.190	
6	fuel	0	534.0	-17.750	3.000	
7	test wt (passenger load)	0	6720	-22.000	8.500	
8	Total Weight=		13552	LCG=-23.281	VCG=6.249	

Illustration #1



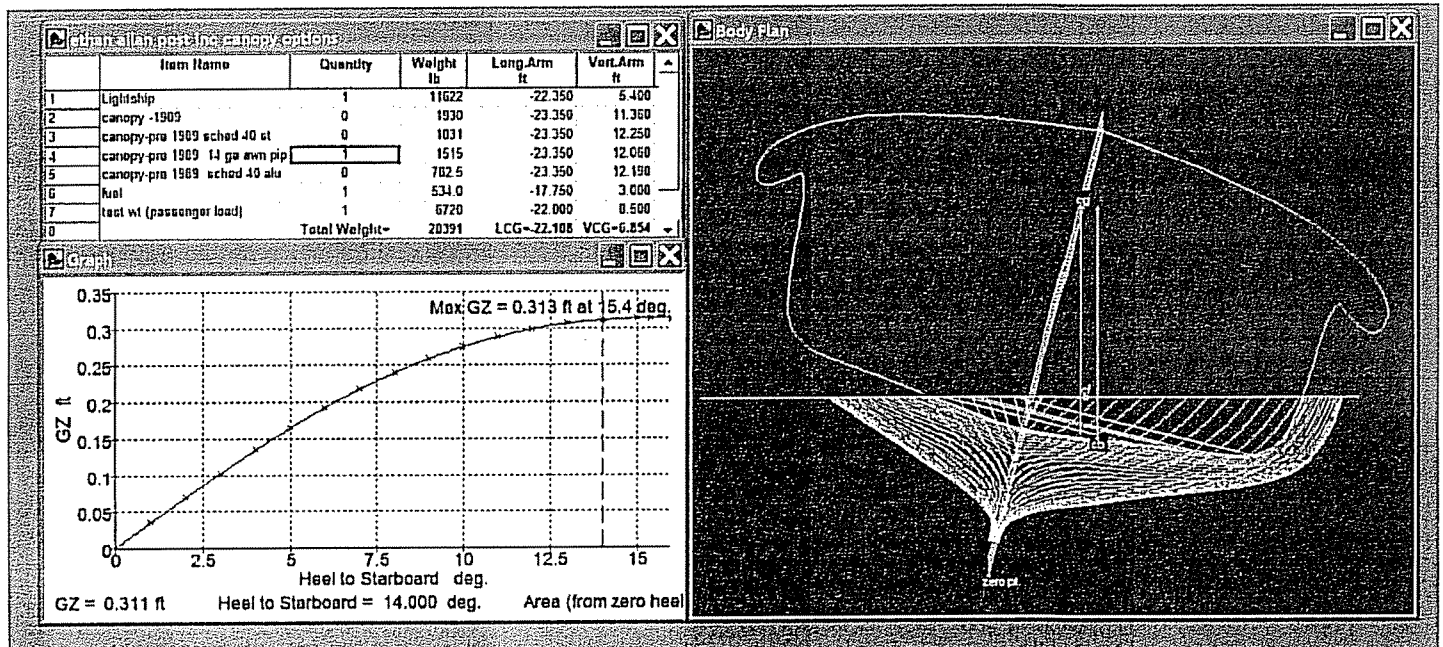
Heel Analysis showing .297(20,806lbs) = 6,179 ft-lbs RM at 14 deg with post 1989 Canopy

Illustration #2



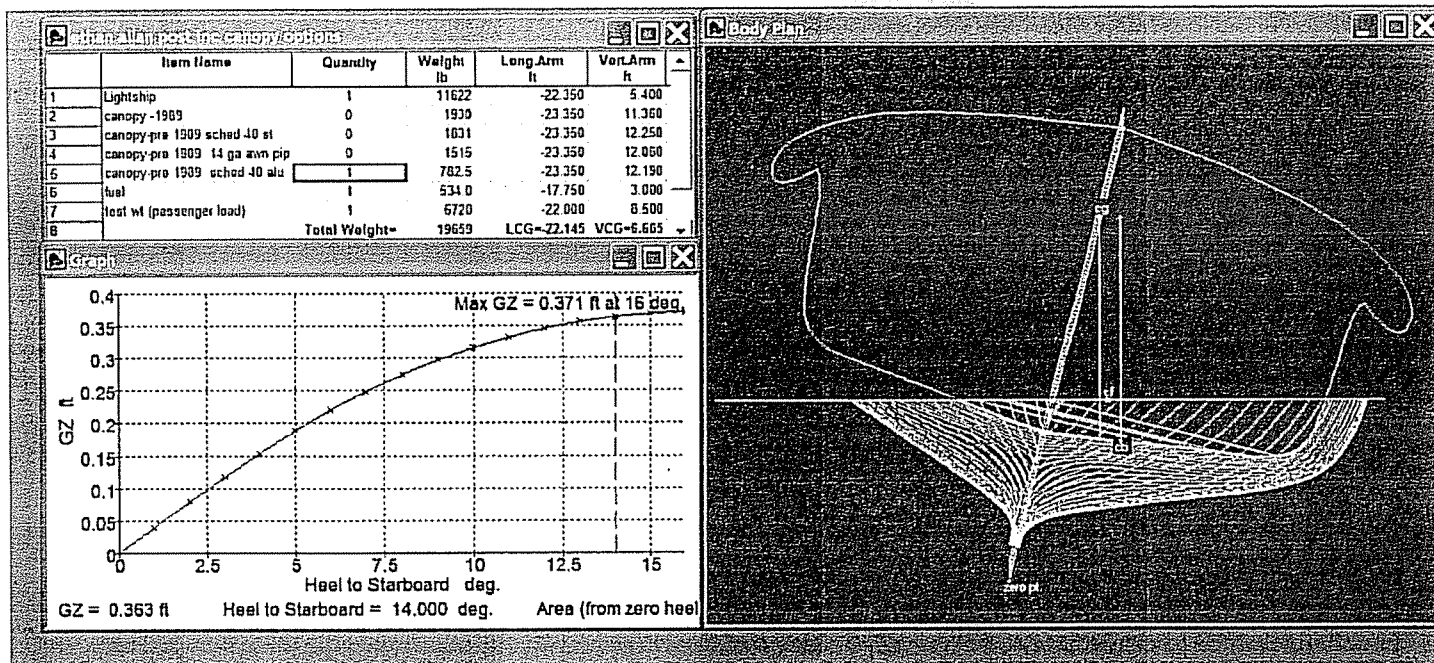
Heel Analysis showing .284'(20,707lbs) = 5,881 ft-lbs of RM available at 14 deg with pre 1989 Canopy (if sched 40 steel pipe)

Illustration #3



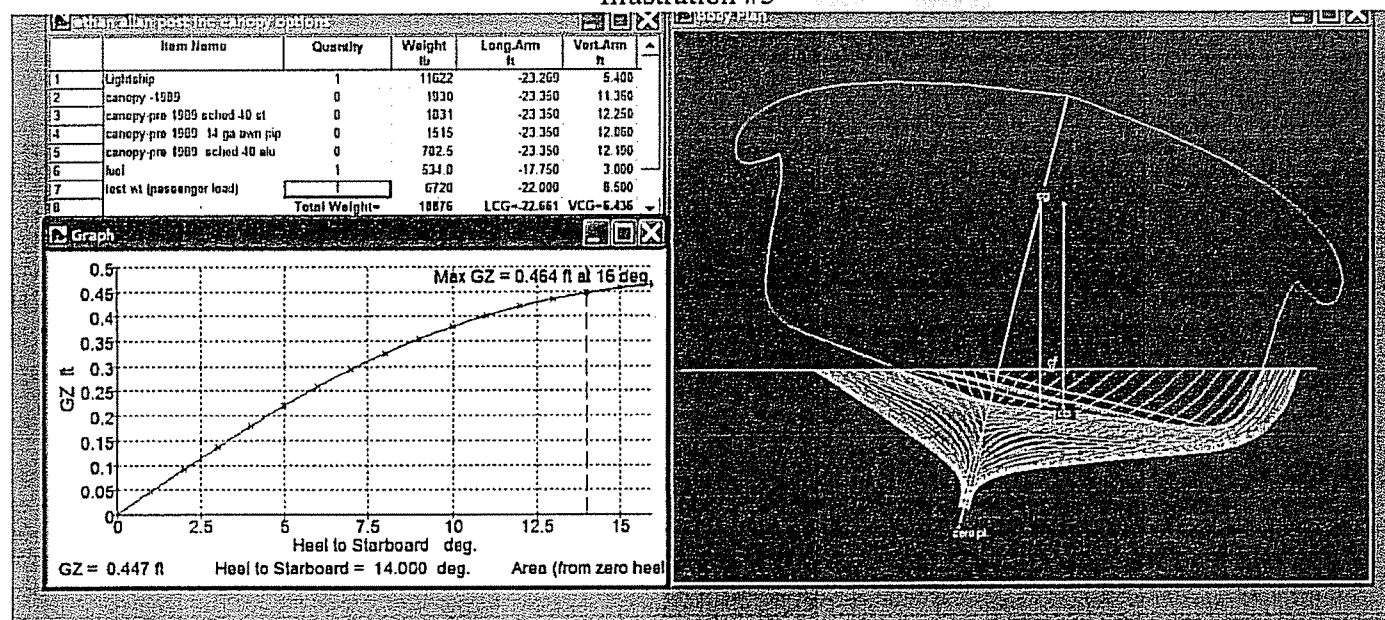
Heel Analysis showing .311'(20,391lbs) = 6,342 ft-lbs of RM available at 14 deg with pre 1989 Canopy (if 14 gauge awning pipe)

Illustration #4



Heel Analysis showing .363'(19,659lbs) = 7,136 ft-lbs of RM available at 14 deg with pre 1989 Canopy (if alum sched 40 pipe)

Illustration #5



Heel Analysis showing .447'(18,876lbs) = 8,438 ft-lbs of RM available at 14 deg with no Canopy weight.

Table 2

Summary of vessel stability requirements to meet standard and characteristics at Simplified Stability Test
Loading at 14° with various canopy configurations.

	VCG ft	RA ft	Disp lbs	RM ftlbs	USCG Req RM ftlbs	No. of Pass. allowed by standard
post '89 canopy	6.89	.297	20,806	6,179	12,565	0
pre '89 canopy if sched 40 st pipe	6.95	.284	20,707	5,881	15,166	0
pre '89 canopy if 14 ga awning pipe	6.85	.311	20,391	6,342	15,166	0
pre '89 canopy if alum pipe	6.67	.363	19,659	7,136	15,166	0
pre '89 canopy if no weight	6.55	.447	18,876	8,438	15,166	0

The raw data used in this analysis are supported as follows:

- 1) Weights of canopies are calculated as shown on attached spreadsheet. Length of pre '89 canopy pipe was taken from attached photograph. Most likely material, according to canopy professionals, is either sched 40 pipe considering early 1970's time frame or 14 ga. awning pipe. Size of pipe was estimated by comparison to existing features in the photograph. Windows were assumed to be similar for both canopies.
- 2) USCG Simplified Stability Test required moment is taken from Oct 5 05 stability test document (pg 4) of ETHAN ALLEN sistership DeCHAMPLAIN for post '89 canopy. Moment for pre '89 configuration is taken by adding one foot of additional height to post '89 canopy. Attached photographs and dimensions illustrate height difference of at least 1'.
- 3) Each Illustrated RM @ 14° Heel Analysis was based on vessel lightship characteristics taken from inclining. Loading condition for each analysis was adjusted for change to various possible canopy configurations. Tankage and passenger weights were included to simulate Simplified Stability Test condition.

Figure 2

Photo of Original Canopy showing area from which known and scaled dimensions were developed.



Figure 3

Sketch of Current Canopy showing area from which known and scaled dimensions were developed.

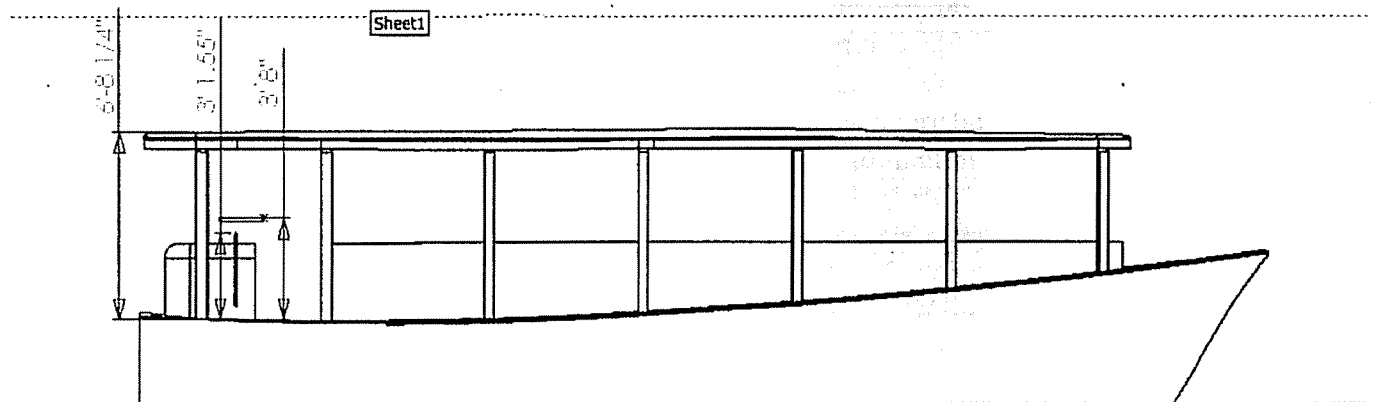


Figure 4

Pre 1989 photo showing known and scaled canopy dimensions.

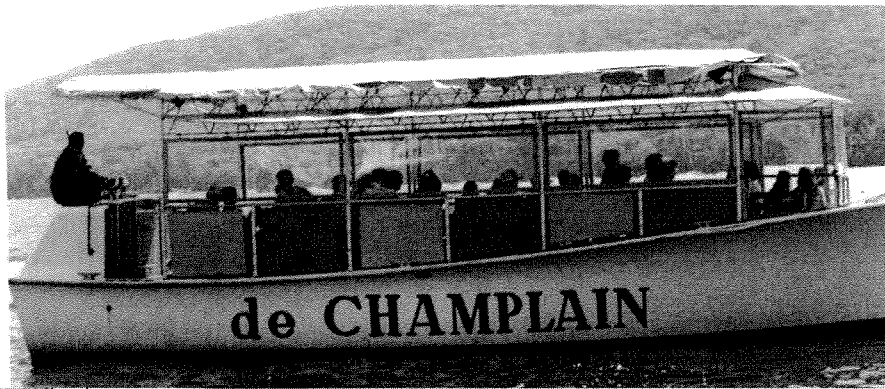


Figure 5
Post 1989 sketch showing known and scaled canopy dimensions.

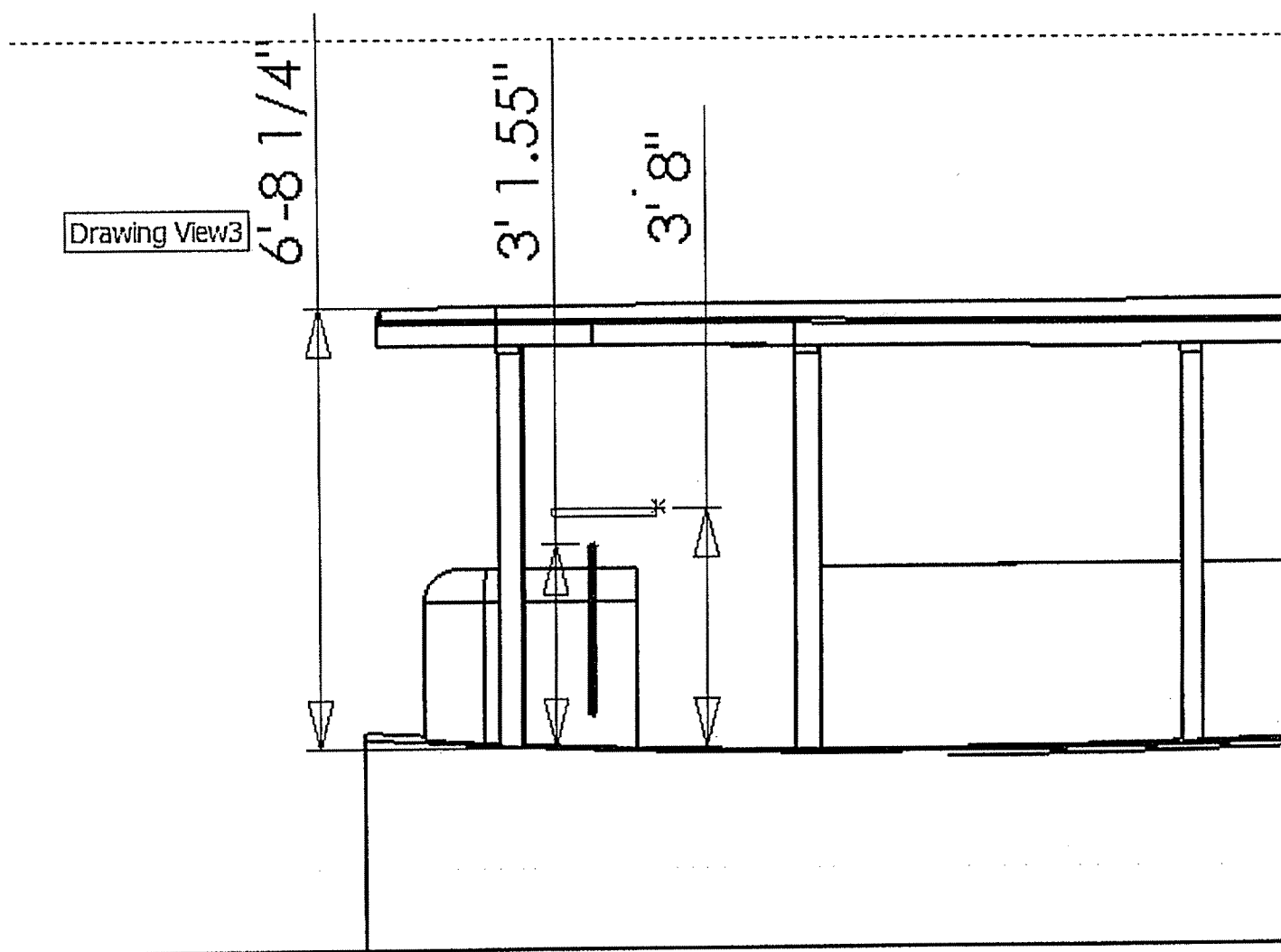


Figure 6

[illegible]

SCARANO BOAT BUILDING, INC.

May 5, 2006

Modified page 2 bar chart from "Effects of Various Canopy Configurations on Vessel ETHAN ALLEN's Ability to Satisfy USCG Stability Standard" using JMS model. Supporting analysis. showing the max GZ at various configurations is also shown below.

The below demonstrates that no significant difference in the relative effects of the canopy modification exist between the SBI or JMS models.

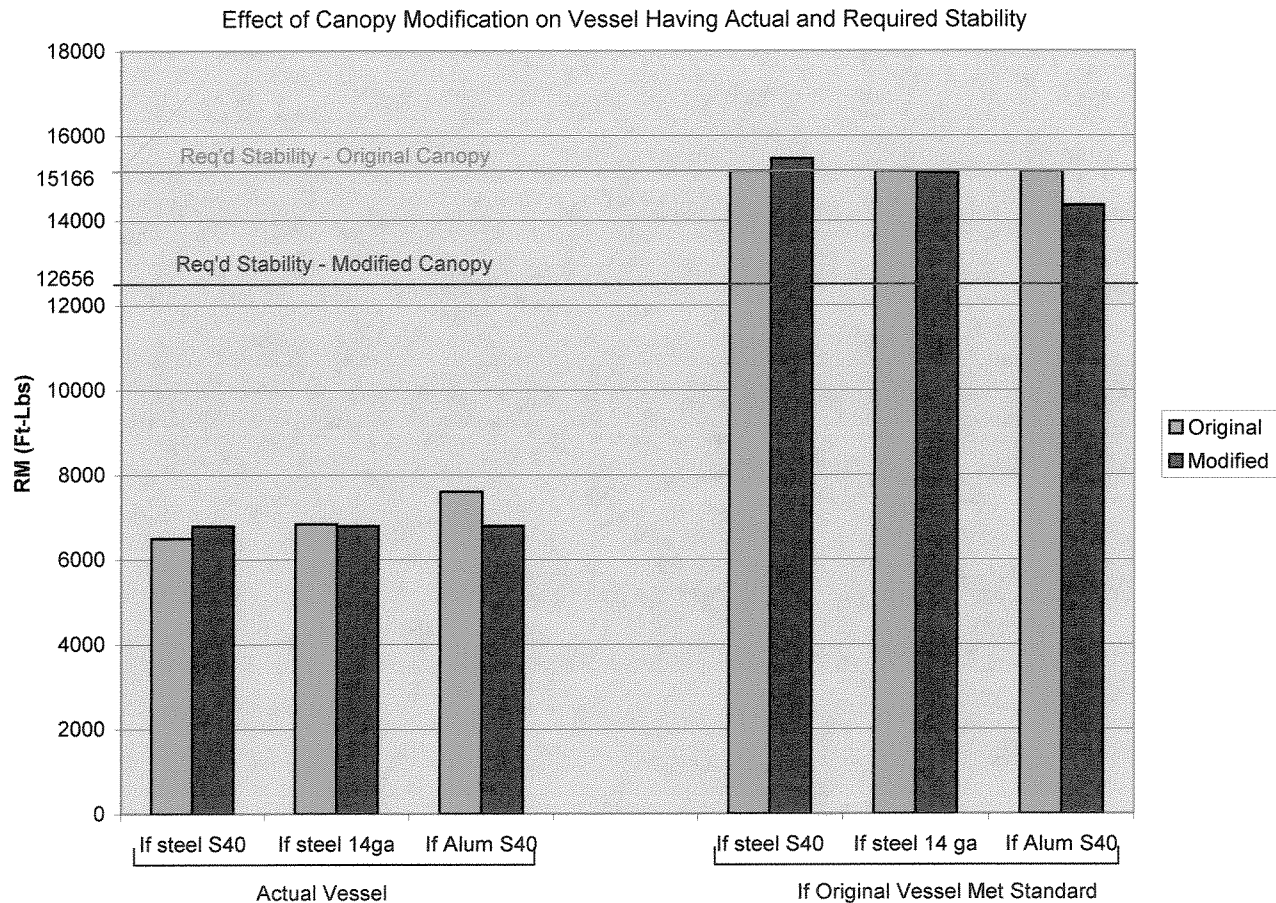
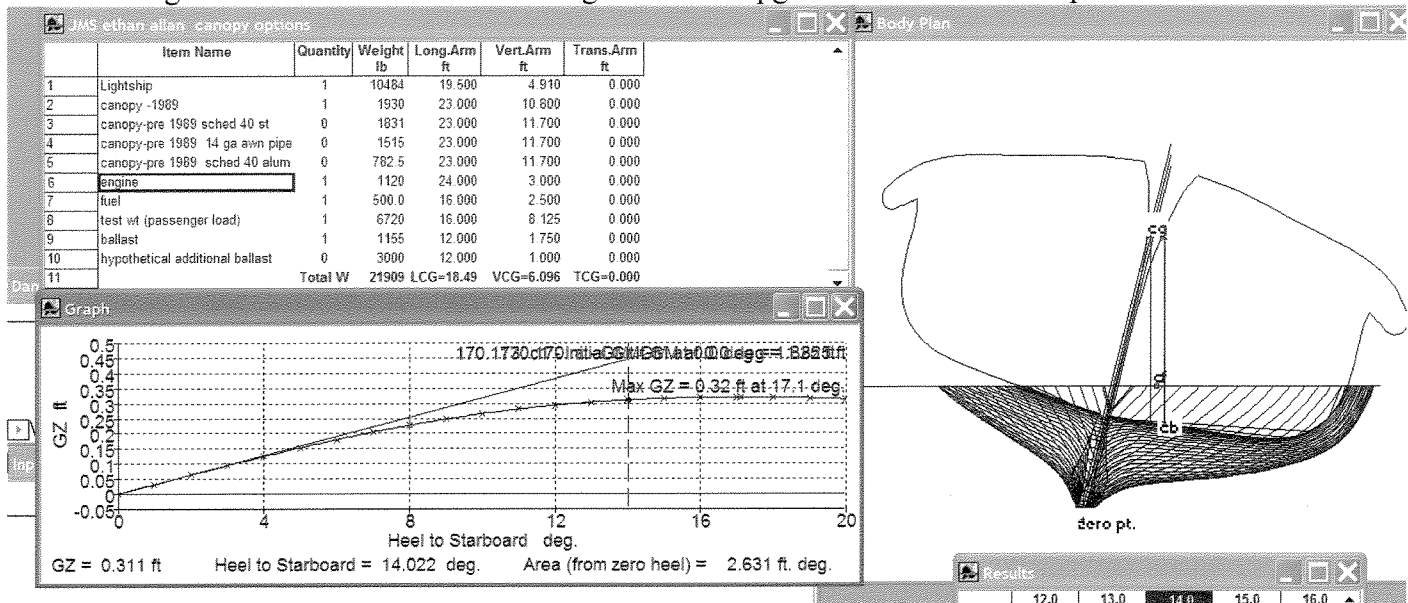
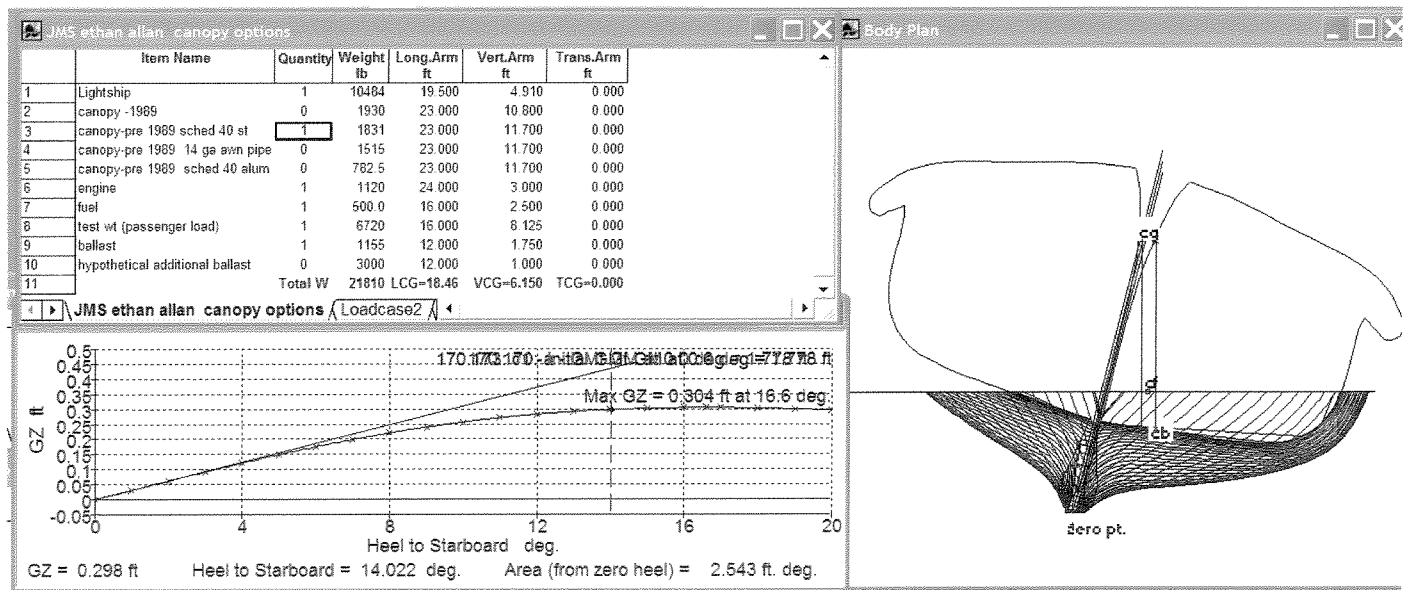


Illustration #1 From JMS Model (matches 18,000 flb pg11 figure 5 of JMS Report)
 Also note loading is matched to steel, aluminum, and wood canopy VCGs shown on pg B-2 and that heeling moments can be matched to Fig. 5 and 6 on pgs 11 and 12 of JMS report.



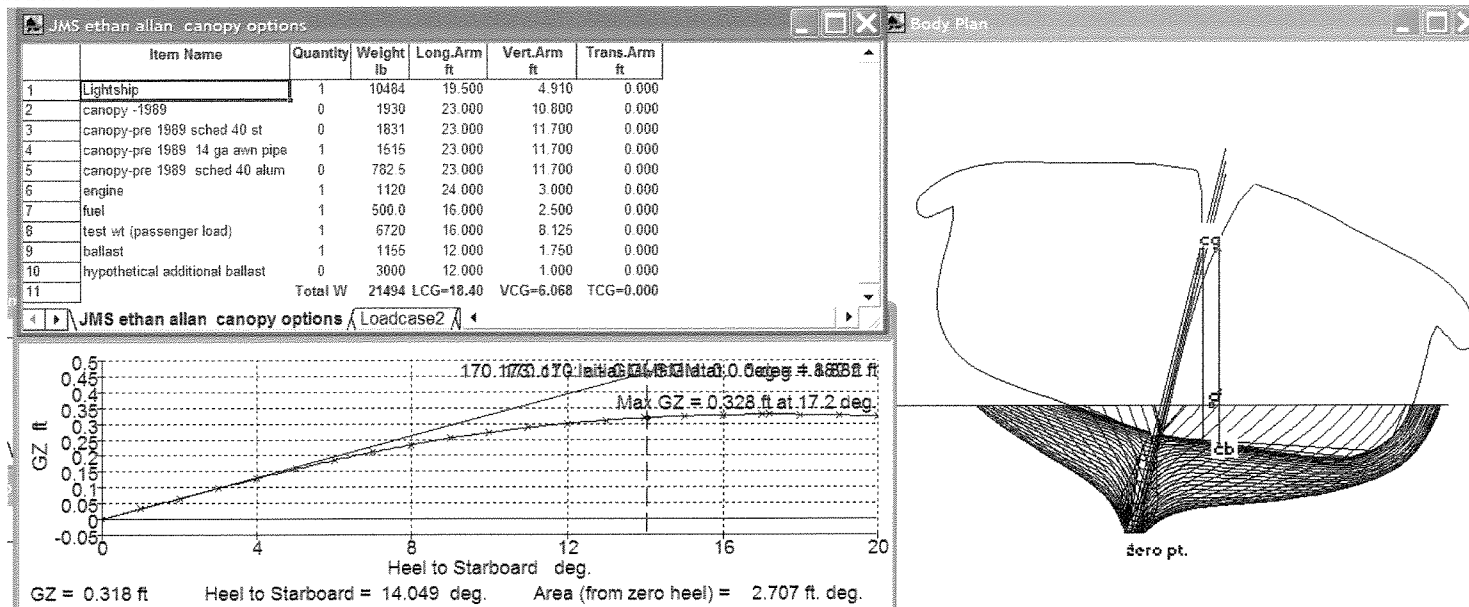
Heel Analysis showing .32(21909) = 6,791 ft-lbs with post 89 canopy

Illustration #1 From JMS Model



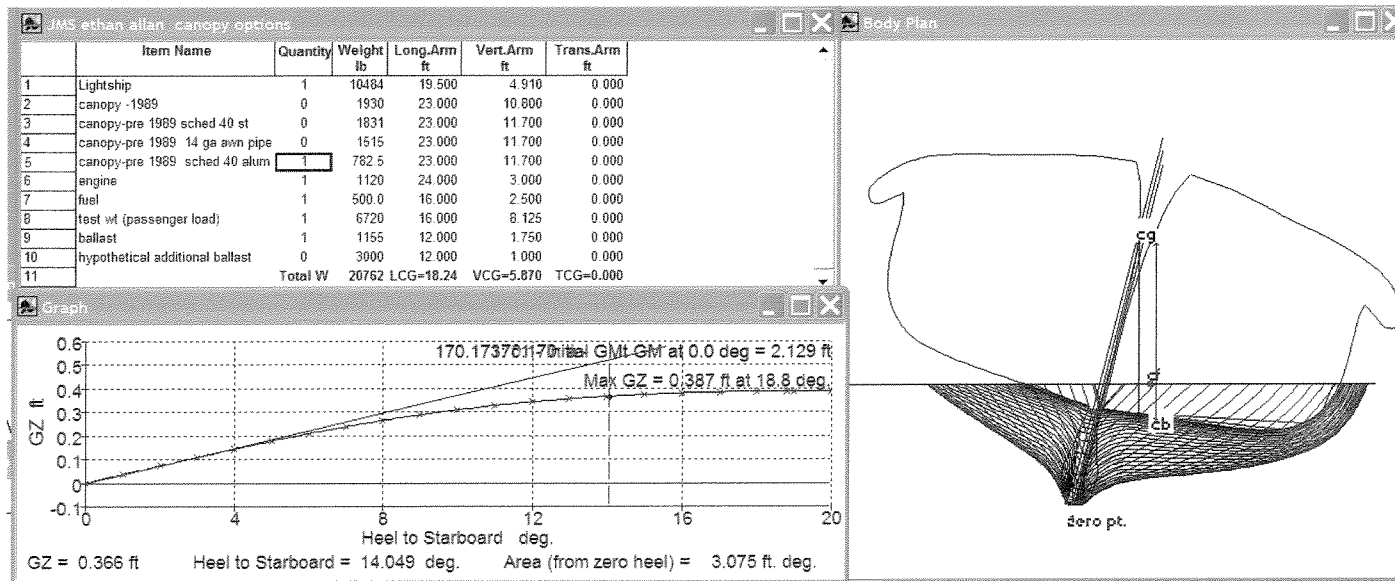
Heel Analysis showing .298(21810) = 6,499 ft-lbs of RM available at 14 deg with pre 1989 canopy (if sched 40 steel pipe)

Illustration #3 From JMS Model



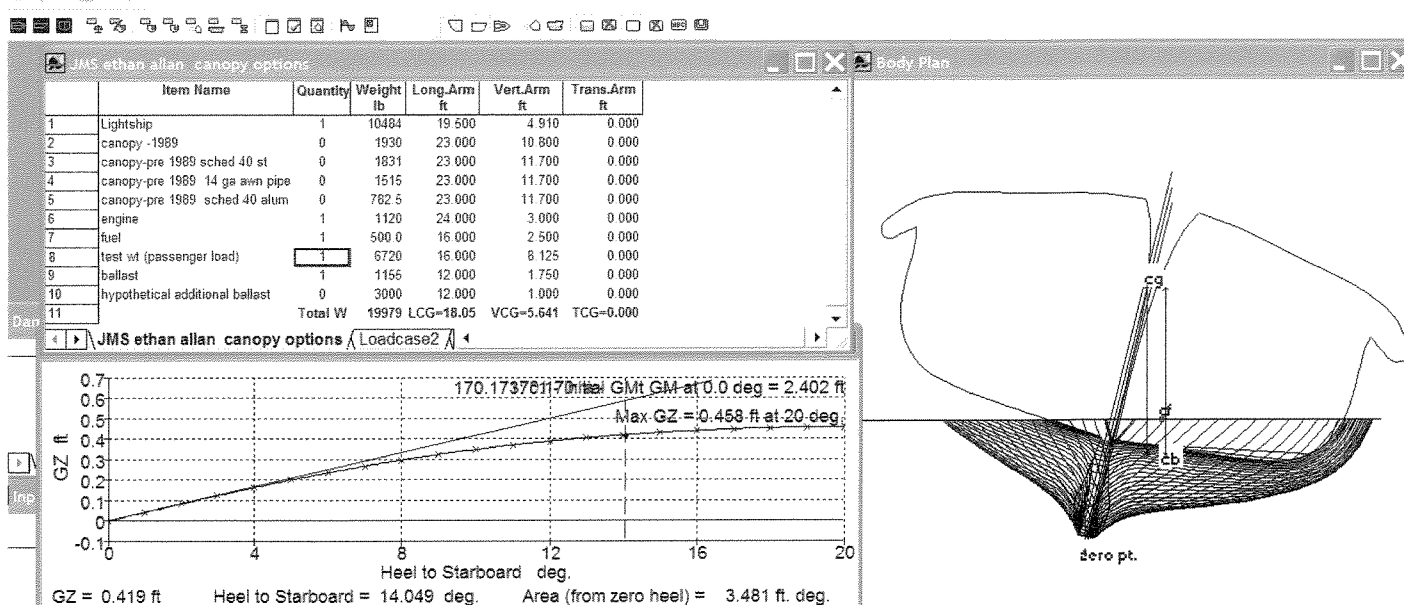
Heel Analysis showing $.318(21,494) = 6,835$ ft-lbs of RM available at 14 deg with pre 1989 canopy (if 14 gauge awning pipe)

Illustration #4 From JMS Model



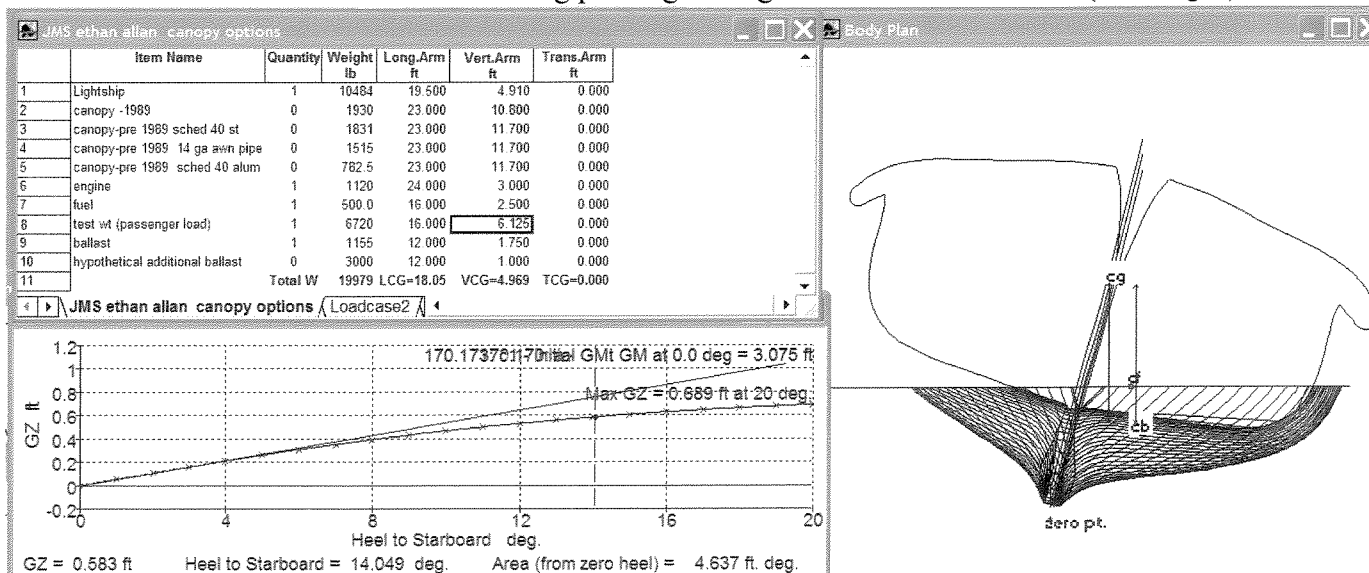
Heel Analysis showing $.366(20762) = 7,599$ ft-lbs of RM available at 14 deg with pre 1989 canopy (if sched 40 aluminum)

Illustration #5 From JMS Model



Heel Analysis showing .419(19979) = 8371.2 ft-lbs of RM available at 14 deg with no canopy.

Illustration #6 From JMS Model showing passenger weight .125' above the deck (sandbags?)



Heel Analysis showing .583(19979) = 11,647 ft-lbs of RM available at 14 deg with no canopy.

So it would maybe just pass with top of sandbags 3" off the deck as requirement is 11,659 ft-lbs.